

**We Claim:**

1. A system for debugging a program which is intended to execute on a reconfigurable device, the system comprising:

5 a reconfigurable device, comprising:

a programmable hardware element; and

one or more fixed hardware resources coupled to the programmable hardware element; and

a computer system comprising a processor and a memory;

10 wherein the computer system is coupled to the reconfigurable device;

wherein the memory stores the program specifying a function, wherein the program is convertible into a hardware configuration program which specifies a configuration for the programmable hardware element that implements the function, and wherein the hardware configuration program further specifies usage of the one or more  
15 fixed hardware resources by the programmable hardware element in performing the function;

wherein the programmable hardware element is further configurable with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between  
20 the program and the one or more fixed hardware resources; and

wherein, for debugging purposes, the program is further executable by the processor of the computer system to test performance of the function including the usage of the one or more fixed hardware resources.

25 2. The system of claim 1, wherein during execution of the program in the computer system, the program is operable to communicate through the programmable hardware element configured with the test feed-through configuration to invoke the one or more fixed hardware resources.



system to communicate through the programmable hardware element to the fixed hardware resources.

12. The system of claim 1, wherein the programmable hardware element  
5 comprises an field programmable gate array (FPGA).

13. The system of claim 1,  
wherein the programmable hardware element is configured to implement a  
processor, wherein the device further comprises a memory, and wherein a portion of the  
10 program is stored in the memory;  
wherein the program is compiled for the implemented processor; and  
wherein, for debugging purposes, the compiled program is executable on the  
implemented processor to test performance of the function including the usage of the one  
or more fixed hardware resources.

15 14. The system of claim 1,  
wherein the one or more fixed hardware resources are operable to provide one or  
more of:  
a control and data path to the computer system;  
20 I/O interfacing to an external system;  
optimized hardware elements; and  
basic operating services.

25 15. The system of claim 1,  
wherein the one or more fixed hardware resources comprise fixed hardware  
including one or more of:  
analog to digital converters (ADCs), digital to analog converters (DACs), and  
digital lines.

16. A system for debugging a measurement program which is usable to configure a reconfigurable measurement device, the system comprising:

the reconfigurable measurement device comprising:

a programmable hardware element;

5 one or more fixed hardware resources coupled to the programmable hardware element; and

a computer system comprising a processor and a memory;

wherein the computer system is coupled to the reconfigurable measurement device;

10 wherein the memory stores the measurement program specifying a measurement function;

wherein the programmable hardware element is further configurable with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between  
15 the one or more fixed hardware resources and the measurement program; and

wherein, for debugging purposes, the measurement program is further executable by the processor of the computer system to test performance of the measurement function including the usage of the one or more fixed hardware resources.

20 17. The system of claim 16,

wherein the measurement program is convertible into a hardware configuration program which specifies a configuration for the programmable hardware element that implements the measurement function, and wherein the hardware configuration program further specifies usage of the one or more fixed hardware resources by the programmable  
25 hardware element in performing the measurement function

18. The system of claim 16, wherein the memory stores the test feed-through configuration in a pre-compiled format.

19. The system of claim 7, wherein the programmable hardware element comprises a field programmable gate array (FPGA).

20. The system of claim 1, wherein during execution of the program in the  
5 computer system, the program is operable to communicate through the programmable hardware element configured with the test feed-through configuration to invoke the one or more fixed hardware resources.

21. The system of claim 1, wherein execution of the program on the computer  
10 system simulates execution of the hardware configuration program on the programmable hardware element.

22. The system of claim 1, wherein the computer system includes a display for  
15 displaying one or more panels, wherein the one or more panels display information specifying the functionality of the program.

23. A system for debugging a reconfigurable measurement system, the system comprising:

20 a programmable hardware element;  
one or more fixed hardware resources coupled to the programmable hardware element; and

a computer system comprising a processor and a memory;  
wherein the computer system is coupled to the programmable hardware  
element;

25 wherein the memory stores a measurement program specifying a measurement function, wherein the measurement program is convertible into a hardware configuration program which specifies a configuration for the programmable hardware element that implements the measurement function, and wherein the hardware configuration program further specifies usage of the one or more fixed hardware

resources by the programmable hardware element in performing the measurement function;

wherein the programmable hardware element is further configurable with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between  
5 the one or more fixed hardware resources and the program; and

wherein, for debugging purposes, the measurement program is further executable by the processor of the computer system to test performance of the measurement function including the usage of the one or more fixed hardware resources.

10

24. The system of claim 23, wherein during execution of the program in the computer system, the measurement program is operable to communicate through the programmable hardware element configured with the test feed-through configuration to invoke the one or more fixed hardware resources.

15

25. The system of claim 23, wherein the test feed-through configuration is pre-compiled.

20

26. The system of claim 23, wherein the computer system includes a display for displaying one or more panels, wherein the one or more panels display information specifying the functionality of the program.

25

27. The system of claim 23, wherein the programmable hardware element comprises a field programmable gate array (FPGA).

28. The system of claim 23, wherein execution of the program on the computer system simulates execution of the hardware configuration program on the programmable hardware element.

29. A method for debugging a program which is usable to configure a reconfigurable system, wherein the reconfigurable system includes a programmable hardware element coupled to one or more fixed hardware resources, the method  
5 comprising:

storing a program on a memory of a computer system, wherein the program specifies a function, and wherein the program is operable to be converted into a hardware configuration program and deployed on the programmable hardware element;

wherein the program is operable to be converted into a hardware configuration  
10 program that uses the one or more fixed hardware resources when executed on the programmable hardware element;

configuring the programmable hardware element with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between the program and  
15 the one or more fixed hardware resources; and

the computer system executing the program, wherein said executing includes the program communicating with the one or more fixed hardware resources through the programmable hardware element.

20 30. The method of claim 29, wherein said executing the program includes the program invoking the one or more fixed hardware resources through the programmable hardware element configured with the test feed-through configuration.

31. The method of claim 29, wherein said executing the program simulates  
25 execution of the hardware configuration program on the programmable hardware element.

32. The method of claim 29, further comprising:  
displaying information on a display regarding said executing the program.

33. The method of claim 32, wherein the information is useable in debugging the program.

5 34. The method of claim 29, wherein the test feed-through configuration is pre-compiled.

35. The method of claim 29, wherein the computer system includes a display for displaying one or more panels, wherein the one or more panels display information  
10 specifying the functionality of the program.

36. The method of claim 29, wherein the program is a measurement program which is executable to perform a measurement function.

15 37. The method of claim 29, wherein the program is an automation program which is executable to perform an automation function.

38. The method of claim 29, wherein the program is a simulation program which is executable to perform a simulation function.  
20

39. The method of claim 29, wherein the program is a control program which is executable to perform a control function.

40. The method of claim 29, wherein the programmable hardware element  
25 comprises an field programmable gate array (FPGA).

41. The method of claim 29,  
wherein the one or more fixed hardware resources comprise fixed hardware including one or more of:



analog to digital converters (ADCs), digital to analog converters (DACs), and digital lines.

42. The method of claim 29, wherein said executing includes the one or more  
5 fixed hardware resources providing one or more of:

a control and data path to the computer system;  
I/O interfacing to an external system;  
optimized hardware elements; and  
basic operating services.

10

43. The method of claim 29,

wherein the program includes one or more I/O primitives, wherein the one or  
more I/O primitives are convertible into a portion of a hardware configuration program to  
invoke the one or more fixed hardware resources, and wherein said executing includes  
15 executing the one or more I/O primitives in the program on the computer system to  
communicate through the programmable hardware element to the one or more fixed  
hardware resources.

44. The method of claim 29, wherein the program is a graphical program.

20

45. The method of claim 29,

wherein the programmable hardware element is configured to implement a  
processor, wherein the device further comprises a memory, and wherein a portion of the  
program is stored in the memory;

25

wherein the program is compiled for the implemented processor; and

wherein, for debugging purposes, the compiled program is executable on the  
implemented processor to test performance of the function including the usage of the one  
or more fixed hardware resources.

46. A method for debugging a measurement program which is usable to configure a reconfigurable measurement device, wherein the device includes a programmable hardware element coupled to one or more fixed hardware resources, the method comprising:

5 storing a measurement program on a memory of a computer system, wherein the measurement program specifies a measurement function, and wherein the measurement program is operable to be converted into a hardware configuration program and deployed on the programmable hardware element;

wherein the measurement program specifies a hardware configuration program  
10 that is operable to use one or more fixed hardware resources coupled to the programmable hardware element

configuring the programmable hardware element with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between the program and  
15 the one or more fixed hardware resources;

the computer system executing the measurement program, wherein said executing includes the measurement program communicating with the one or more fixed hardware resources through the programmable hardware element.

20 47. The method of claim 46, wherein the test feed-through configuration is pre-compiled.

48. The method of claim 46, wherein said executing the measurement program includes the measurement program invoking the one or more fixed hardware  
25 resources through the programmable hardware element configured with the test feed-through configuration

49. The method of claim 46,

wherein said executing the measurement program simulates execution of the hardware configuration program on the programmable hardware element.

50. The method of claim 46, further comprising:  
5 displaying information on a display regarding said executing the measurement program.

51. The method of claim 49, wherein the information is useable in debugging the measurement program.  
10

52. The method of claim 46, wherein the computer system includes a display for displaying one or more panels, wherein the one or more panels display information specifying the functionality of the measurement program.

53. The method of claim 46, wherein the programmable hardware element comprises an field programmable gate array (FPGA).  
15

54. The method of claim 46,  
wherein the one or more fixed hardware resources comprise fixed hardware  
20 including one or more of:  
analog to digital converters (ADCs), digital to analog converters (DACs), and digital lines.

55. The method of claim 46, wherein said executing includes the one or more  
25 fixed hardware resources providing one or more of:  
a control and data path to the computer system;  
I/O interfacing to an external system;  
optimized hardware elements; and  
basic operating services.

105564 105564

56. The method of claim 46,

wherein the measurement program includes one or more I/O primitives, wherein the one or more I/O primitives are convertible into a portion of a hardware configuration  
5 program to invoke the one or more fixed hardware resources, and wherein said executing includes executing the one or more I/O primitives in the measurement program on the computer system to communicate through the programmable hardware element to the one or more fixed hardware resources.

10 57. The method of claim 46, wherein the measurement program is a graphical program.

58. The method of claim 46,

wherein the programmable hardware element is configured to implement a  
15 processor, wherein the device further comprises a memory, and wherein a portion of the measurement program is stored in the memory;

wherein the measurement program is compiled for the implemented processor;  
and

wherein, for debugging purposes, the compiled measurement program is  
20 executable on the implemented processor to test performance of the function including the usage of the one or more fixed hardware resources.

59. A memory medium comprised in a computer system, comprising:

a program that specifies a function, wherein the program is operable to be  
25 converted into a hardware configuration program and deployed on a programmable hardware element;

a hardware configuration program generated based on the program, wherein the hardware configuration program specifies a configuration for the programmable hardware element that implements the function, and wherein the hardware configuration

program further specifies usage of the one or more fixed hardware resources by the programmable hardware element in performing the function; and

a test configuration;

5 a deployment program executable to deploy the test configuration onto the programmable hardware element, wherein, after configuration with the test configuration, the programmable hardware element provides for communication between the one or more fixed hardware resources and the program;

wherein the program is executable by a processor in the computer system, wherein during execution the program communicates with the one or more fixed  
10 hardware resources through the programmable hardware element.

60. The memory medium of claim 59,  
wherein the test configuration is a test feed-through configuration.

15 61. The memory medium of claim 59, wherein execution of the program by the processor simulates execution of the hardware configuration program on the programmable hardware element.

62. The memory medium of claim 59, further comprising:  
20 a display program which is executable to display information on a display regarding said executing the program, wherein the information is useable in debugging the program.

63. The memory medium of claim 59, wherein the test configuration is pre-  
25 compiled.

64. The memory medium of claim 59, wherein the program is a measurement program which is executable to perform a measurement function.

65. The memory medium of claim 59, wherein the program is an automation program which is executable to perform an automation function.

66. The memory medium of claim 59, wherein the program is a simulation  
5 program which is executable to perform a simulation function.

67. The memory medium of claim 59, wherein the program is a control program which is executable to perform a control function.

10 68. The memory medium of claim 59, further comprising:  
a graphical program comprising one or more panels for displaying information specifying the functionality of the program..

69. A memory medium containing program instructions which are executable  
15 to perform:

storing a measurement program on a memory of a computer system, wherein the measurement program specifies a measurement function, and wherein the measurement program is operable to be converted into a hardware configuration program and deployed on a programmable hardware element;

20 wherein the hardware configuration program specifies usage of one or more fixed hardware resources by the programmable hardware element;

configuring the programmable hardware element with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between the one or more  
25 fixed hardware resources and the measurement program;

executing the measurement program, wherein said executing includes the measurement program communicating with the one or more fixed hardware resources through the programmable hardware element.

70. The memory medium of claim 69, wherein said executing the measurement program includes the program invoking the one or more fixed hardware resources through the programmable hardware element configured with the test feed-through configuration.

5

71. The memory medium of claim 69, wherein said executing the measurement program simulates execution of the hardware configuration program on the programmable hardware element.

10 72. The memory medium of claim 69, wherein the program instructions are further executable to perform:

displaying information on a display regarding said executing the measurement program, wherein the information is useable in debugging the program.

15 73. The memory medium of claim 69, wherein the test feed-through configuration is pre-compiled.

74. The memory medium of claim 69, wherein the computer system includes a display for displaying one or more panels, wherein the program instructions are further  
20 executable to implement the one or more panels, and wherein the one or more panels display information specifying the functionality of the measurement program.

75. The memory medium of claim 69, wherein the programmable hardware element comprises an field programmable gate array (FPGA).

25

76. A memory medium containing program instructions which are executable to perform:

storing a program on a memory of a computer system, wherein the software program specifies a function, and wherein the software program is operable to be

converted into a hardware configuration program and deployed on the programmable hardware element;

wherein the hardware configuration program specifies usage of the one or more fixed hardware resources by the programmable hardware element;

5        configuring the programmable hardware element with a test feed-through configuration, wherein, after configuration with the test feed-through configuration, the programmable hardware element provides for communication between the one or more fixed hardware resources and the software program;

10        executing the software program, wherein said executing includes the software program communicating with the one or more fixed hardware resources through the programmable hardware element.

77.    The memory medium of claim 76, wherein said executing the measurement program includes the program invoking the one or more fixed hardware resources through the programmable hardware element configured with the test feed-through configuration.

78.    The memory medium of claim 76, wherein said executing the measurement program simulates execution of the hardware configuration program on the programmable hardware element.

79.    The memory medium of claim 76, wherein the program instructions are further executable to perform:

25        displaying information on a display regarding said executing the measurement program, wherein the information is useable in debugging the program.

80.    The memory medium of claim 76, wherein the test feed-through configuration is pre-compiled.



81. The memory medium of claim 76, wherein the software program is a measurement software program which is executable to perform a measurement function.

82. The memory medium of claim 76, wherein the software program is an automation software program which is executable to perform an automation function.

83. The memory medium of claim 76, wherein the software program is a simulation software program which is executable to perform a simulation function.

84. The memory medium of claim 76, wherein the software program is a control software program which is executable to perform a control function.

85. A memory medium comprised in a computer system, comprising:  
a user interface program which is executable to receive user input specifying a function;

a configuration generation program which is executable to generate a hardware configuration program based on the user input, where the hardware configuration program is deployable on a programmable hardware element, and wherein the hardware configuration program specifies a configuration for the programmable hardware element that implements the function, and wherein the hardware configuration program further specifies usage of one or more fixed hardware resources by the programmable hardware element in performing the function; and

a test configuration;

a deployment program executable to deploy the test configuration onto the programmable hardware element, wherein, after configuration with the test configuration, the programmable hardware element provides for communication between the one or more fixed hardware resources and the program;

wherein the program is executable by a processor in the computer system,  
wherein during execution the program communicates with the one or more fixed  
hardware resources through the programmable hardware element.

5           86.     The memory medium of claim 85,  
              wherein the test configuration is a test feed-through configuration.

              87.     The memory medium of claim 85, wherein execution of the program by  
the processor simulates execution of the hardware configuration program on the  
10    programmable hardware element.

              88.     The memory medium of claim 85, wherein the programmable hardware  
element comprises an field programmable gate array (FPGA).

15

4055694 4055694